MEMORANDUM OF UNDERSTANDING

BETWEEN

SANDIA CORPORATION, operator of SANDIA NATIONAL LABORATORIES FOR THE DEPARTMENT OF ENERGY ALBUQUERQUE, NM

AND

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GLENN RESEARCH CENTER AT LEWIS FIELD CLEVELAND, OH

REGARDING

THE DEVELOPMENT AND IMPLEMENTATION OF STRATEGIC TECHNICAL COLLABORATION ACTIVITIES

I. PURPOSE

This Memorandum of Understanding establishes the roles of Sandia Corporation, operator of Sandia National Laboratories (Sandia) under Contract Number DE-AC04-94AL85000 for the U.S. Department of Energy (DOE), with facilities located in Albuquerque, NM and in Livermore, CA and the National Aeronautics and Space Administration (NASA) Glenn Research Center at Lewis Field (GRC) in Cleveland, OH for defining and implementing mutually beneficial strategic technical collaboration activities between the two organizations.

II. BACKGROUND

Sandia has developed a set of eight strategic objectives to focus on the future while accomplishing its primary mission to ensure that the nuclear weapons stockpile is safe, secure and reliable and is fully capable of supporting our nation's deterrence policy. The first set of four strategic objectives focus on ***what*** Sandia will accomplish: Nuclear Weapons, Nonproliferation and Materials Control, Energy and Critical Infrastructure, and Emerging National Security Threats. The second set of four strategic objectives focus on ***how*** Sandia will accomplish its mission: People, Science and Technology, Infrastructure, and Partnerships. Throughout its 50 year history as a DOE multiprogram laboratory, Sandia has become the systems integrator for numerous programs in support of not only DOE as its primary customer, but other federal agencies as well, for example, the Department of Defense (DoD). Major relevant programs include both space based and aeronautical systems. Sandia has developed world class science and technology facilities and expertise in the areas of combustion research,

integrated microelectronics systems, robotics, product realization, model based simulation and surety science (safety, quality and reliability). Sandia continues to conduct mission-related research and development in the general areas of processes and materials, computational and information sciences, microelectronics and photonics, pulsed power and engineering sciences. A key to Sandia's mission success is its use of strategic partnerships with industry, universities and other government laboratories to leverage, develop and apply technologies and systems integration to solve major challenges to our nation -- while striving to provide the highest value for taxpayer dollars.

The National Aeronautics and Space Administration's (NASA) Glenn Research Center at Lewis Field (GRC), formerly the Lewis Research Center, has conducted basic research and technology development in propulsion, power and communications for aeronautical and space flight applications since 1941. GRC maintains program management, testing and simulation facilities and human resource expertise to conduct basic and applied research and technology development efforts in support of NASA's four primary Enterprises: Space Science, Earth Science, Aero-Space Technology, and the Human Exploration and Development of Space. The GRC mission is conducted through in-house research and technology development efforts and collaborations between GRC and partners in universities, other government agencies and industry.

On July 9, 1992, the NASA Administrator and the Secretary of Energy signed a Memorandum of Understanding regarding energy-related civil space activities for the purpose of establishing DOE's role in supporting the NASA civil space mission and the process for defining and implementing activities between the two agencies.

Following subsequent meetings between Sandia President, Paul Robinson, and NASA Administrator, Daniel Goldin, they challenged the two institutions to explore collaboration opportunities to leverage each other's strengths to accomplish more effectively each institution's mission. Ongoing technical exchange meetings, discussions, videoconferences and electronic mail communications between the Sandia and GRC management and technical staff have produced the identification of more than 40 areas of mutual interest. This extensive mutual interest forms a worthy basis for a formal declaration to collaborate and to pursue and exploit projects and programs of mutual benefit. Coordinated planning for collaboration between Sandia and GRC will enhance the effectiveness of programs in both organizations.

III. POLICY

The intention of the senior management of both institutions is that Sandia and NASA GRC will jointly define and implement collaborative efforts to conduct fundamental and applied scientific and engineering research and to develop advanced technology for the purpose of meeting critical technology needs common to DOE missions and NASA enterprises. These collaborations will be consistent with the goals and objectives of the scientific and engineering research, technology development, technology transfer, and educational missions of Sandia and GRC.

IV. IMPLEMENTATION

A. Strategic Collaboration. Sandia and GRC will together define and conduct joint strategic collaboration activities with the purpose of identifying potential technical and programmatic collaborations that might enhance each institution's performance of its mission.

B. Assignment of Technical Contacts. The senior management of each institution will assign subordinate managers and technical staff to explore technical collaboration opportunities and to propose to the senior management, where appropriate to each institution's mission, collaboration plans for approval and implementation.

C. Collaboration Development. The Technical Contacts will explore technical collaboration opportunities in a way consistent with each institution's programmatic and mission responsibilities and within each institution's legal and regulatory limitations. Exploration of technical collaboration opportunities will be conducted through conversation, technical exchange, videoconference, electronic mail, site visits, and through other means that are considered appropriate by each institution.

D. Collaboration Proposals and Implementations. Technical collaboration proposals that are judged to be sufficiently and mutually beneficial to both institutions by their senior managers will be sanctioned and initiated first through addenda to this MOU and then, as needed, through separate instruments of agreement. A separate instrument will be required when the proposed collaboration: requires a commitment of resources, includes an intention to seek new or additional funds or program responsibilities from external sources, or establishes that one institution's performance could affect the programmatic or contract performance of the other institution. Each institution will establish approval and oversight processes for collaboration proposals and implementations consistent with their organizational structure and programmatic responsibilities.

E. Charter Collaboration Interest Areas. At the time of the establishment of this MOU, the list below of aeronautical and space sciences and technologies are considered candidates judged to be suitable by the management of both institutions for the exploration of technical collaboration opportunities. Through the joint strategic collaboration activities initiated by this MOU, the list of candidate technical areas may be modified.

Charter Collaboration Concept Technologies

1. Fundamental Combustion Research in Micro-Gravity, including, for example: turbulent combustion modeling and experimental data collection, numerical simulation of radiation heat transfer, and advanced combustion diagnostics.
2. Aeronautical and Space Propulsion Combustion Research, including, for example: modeling and experimental combustion of fuel sprays, combustion chemistry and reduced mechanisms, combustion related turbulence and mixing, combustion modeling and simulation at high and low pressures and temperatures, experimental model validation, time-resolved fuel vapor diagnostics, and high pressure and super-critical fuel spray experiments.
3. Methods for Engineering Modeling and Analysis for Structural Dynamics, including, for example: modeling and simulation of non-deterministic or probabilistic analysis methods using high-speed supercomputing.

4. Space Propulsion, including, for example: testing of nuclear propulsion fuels, propulsion related safety, policy and public awareness, and advanced ion-propulsion studies.
5. Planetary Surface Power Systems, including, for example: nuclear power systems, bimodal reactor fuels development, small nuclear reactor systems, solar cell systems, advanced batteries, fuel cells, power electronics and custom controllers.
6. Microminiature Electo-Mechanical Systems (MEMS) Technology, including, for example: Nano Satellites, miniaturization concepts for critical systems, , remote and in-situ sensing, photonics, communications and propulsion systems.
7. Advanced Communications, including, for example: radiation-hardened high speed digital electronic devices; specification analysis; prototype fabrication and testing.
8. Aeronautical and Space Safety, Predictive Reliability, and Maintenance of Systems, including, for example: aircraft and spacecraft safety, structural and nonstructural aging of aircraft, electromagnetic effects on aircraft and systems, risk analysis, development of high purity metals for rotating machinery, and decision support, aeronautical and space propulsion systems, planetary power systems and communications systems.
9. Robotics and Intelligent Systems, including, for example: mars exploration power systems deployment concepts.
10. Space Power Systems, including, for example: solar energy collection technology, microgap thermionic converter concepts, photovoltaic (PV) solar-cell systems including efficiency testing and calibration studies.
11. High Performance Computing, Modeling and Simulation, including, for example: detailed combustion simulations, turbulent aerodynamics and combustion, turbomachinery, structural dynamics, and materials properties.

V. RESPONSIBLE PARTIES

A. Primary Contacts and Coordinators. The Director of the Sandia National Laboratories will assign a person as the primary contact and coordinator of Sandia's implementation of this MOU. The initial assignee for Sandia is the Vice President for Science, Technology and Components. The Director of the NASA Glenn Research Center will assign a person as the primary contact and coordinator of GRC's implementation of this MOU. The initial assignee for GRC is the GRC Director of Space. These coordinators will be responsible for co-chairing the Senior Management Review Group (Section VI), collecting and maintaining information about and status of Sandia/GRC collaboration efforts, and disseminating that information to all concerned parties within their institution.

B. Technical Assignments and Approvals. For the Sandia National Laboratories, Technical Contact assignments and collaboration proposal approvals and oversight will be the responsibility of the Sandia Vice President for Science, Technology and Components. For the NASA Glenn Research Center, Technical Contact assignments and collaboration proposal approvals and oversight for activities associated with aeronautics programs will be the responsibility of the GRC Director of Aeronautics. For the NASA Glenn Research Center, Technical Contact assignments and collaboration proposal approvals and oversight for activities associated with space programs will be the responsibility of the GRC Director of Space. Appropriate managers will concur on collaboration efforts within their organization or program responsibilities.

C. Other Participating Institutions. The development and implementation of collaborative efforts between the Sandia National Laboratories and the NASA Glenn Research Center may involve Department of Energy (DOE) Program Offices, other DOE National Laboratories, DOE Energy Technology Centers, and other DOE facilities, grantees and contractors; and may involve NASA Headquarters Program Offices, NASA Field Centers, other NASA facilities, grantees, and contractors.

VI. SENIOR MANAGEMENT REVIEW GROUP

A Sandia/GRC Senior Management Review Group will be formed to plan and review Sandia/GRC collaboration activity. The group will:

- Define and conduct joint strategic collaboration concerned with new research and technology investments,
- Identify new potential collaboration areas for exploration and development,
- Approve implementation plans and agreements for new specific collaborative efforts,
- Review and evaluate the ongoing development and implementation of specific collaborations, and
- Review programmatic and policy issues of mutual concern.

The Senior Management Review Group activity will be led jointly by the coordinators of each institution's implementation of this MOU. These Co-Chairs of the group will appoint additional members representing their respective institutions, as they deem necessary and appropriate. The Senior Management Review Group will conduct at least two planning and review meetings each year.

VII. ADDITIONAL UNDERSTANDINGS

The parties understand and agree that this MOU will not be construed as constituting any authority to obligate or commit any resources or any transfer of funds. Proposed resource commitments including: funds, effort, facilities, etc., that are to be furnished by one organization to the other will be negotiated and identified in specific and separate implementing agreements. Implementing agreements will include detailed project plans and objectives, identification of specific roles and responsibilities, performance and schedule requirements, management provisions and funding agreements. Proposed collaboration projects will be subject to the availability of funds. Patent and other intellectual property provisions will be included in any such implementing agreement, as needed.

Sandia and GRC will retain exclusive right, title, and interest to their individual underlying technologies. Neither party warrants that any information or technology disclosed to the other party will be merchantable or fit for a particular purpose or free of claims of infringement from third parties.

No claims for consequential damages, incidental damages, claims for lost profits, or other indirect damages arising out of or resulting from the activities conducted under this MOU or under implementing agreements facilitated by this MOU shall be allowed. With regard to

activities undertaken pursuant to this MOU, neither party shall make any claim against the other, employees of the other, the other's related entities (e.g., contractors, subcontractors, investigators or their contractors or subcontractor), or employees of the other's related entities for any injury to, or death of, its own employees or employees of its related entities, or for damage to, or loss of, its own property or that of its related entities, whether such injury, death, damage or loss arises through negligence or otherwise, except in the case of willful misconduct.

VIII. DISCLOSURE OF INFORMATION

Subject to the Freedom of Information Act (5 U.S.C. 552), decisions on the disclosures of information to the public regarding activities sanctioned by this MOU will only be made following consultation between Sandia and GRC regarding the other's activities and with the written consent of both parties.

IX. EFFECTIVE DATE

This MOU is effective upon signature by the responsible persons representing each institution. This MOU will remain in full force and effect for a period of four (4) years from the date of the agreement.

X. TERMINATION

This MOU may be terminated by mutual agreement of the parties hereto. Either party may withdraw from this agreement in its sole discretion upon thirty (30) days' written notice to the other party.

XI. AMENDMENTS

This MOU may be modified or amended only by written agreement between the parties.

Both parties expect that future agreements for technical collaborations, appropriate within limitations described elsewhere in this MOU, may by established through written addenda to this MOU. These addenda will set forth brief descriptions of each institution's relevant programmatic activity and each institution's roles and responsibilities and the major schedule milestones of the collaboration effort.

XII. ENTIRE UNDERSTANDING

The foregoing states the entire understanding between the parties, superseding any previous or contemporaneous understandings, commitments, or agreement, oral or written, with respect to the subject matter of this MOU.

The undersigned approve this memorandum of understanding and are authorized to implement its provisions.

For the SANDIA CORPORATION	**For the NATIONAL AERONATUICS and SPACE ADMINISTRATION GLENN RESEARCH CENTER**
_____	_____
Alton Romig, Vice President for Science, Technology and Components	Donald J. Campbell, Director
Date: _____	Date: _____

Addendum A
Sandia / NASA–GRC MOU dated 4/8/99

Advanced Communications Technology Development and Projects

Sandia and GRC will collaborate on developing advanced communications technology to meet critical technology needs common to DOE's energy and weapons monitoring and surveillance missions and NASA aeronautics and civil space enterprises. Collaboration activities will be consistent with the goals and objectives defined by Sandia's missions and the NASA enterprises.

Sandia's research and development activities involve high-bandwidth, radiation-hardened electronics, power development and advanced modeling and simulation. Sandia has expertise and capabilities that can be applied to the design, development and testing of high data rate communications systems for satellite use. These capabilities include radiation hardened 60 GHz satellite communications cross links, compound semiconductor wafer materials, 0.1 micrometer device design and processing technology, digital Gallium Arsenide (GaAs) integrated circuit (IC) design and processing technology, digital and analog, radiation hardened, silicon integrated circuit design and processing technology, MMIC design and processing technology, micromachine (MEMS) technology, packaging, modeling, testing and system integration technology. Sandia capabilities are currently being applied to the development of advanced nanosatellites. Additional relevant technology exists in modeling and simulation, novel power sources, advanced materials development, robotics and related fields.

GRC conducts research and development in advanced space communications concepts, architectures, components, and systems. Technology expertise and research facilities are focused in four areas: digital communications, vacuum and solid state electronic devices, antenna and RF systems, and satellite networks and architectures. Specific technologies within these four areas include: bandwidth-and power efficient modulation and coding, intelligent onboard processing and switching, radiation hardened digital circuits, electromagnetic computer modeling, electron emission, high temperature superconducting microwave circuits, thin film ferroelectric circuits, monolithic microwave integrated circuit (MMIC) based arrays and array feeds, reflectarrays, MMIC packaging, printed circuit radiating elements, atmospheric propagation, system architectures and networking concepts, Internet protocols, and asynchronous transfer mode (ATM) over satellite. In addition, the Advanced Communications Technology Satellite (ACTS), a high capacity experimental Ka-band (30/20 GHz) satellite developed and operated at GRC, is available for potential experimenters. High gain spot-beam antennas, wide bandwidth transponders, and onboard baseband processing, are some of the advanced features of this satellite.

This collaboration between Sandia and GRC in Advanced Communications Technology Development concerns the development of Radiation Hardened Digital Communications Devices. A description of the proposed collaboration, including the major milestones of the effort, follows:

Radiation-Hardened Digital Communications Devices:

1) High Rate, Radiation-Hardened Digital Modem

GRC is currently developing a radiation-hardened digital modem through a development contract with SiCOM, Inc., a small business located in Scottsdale, AZ. The initial phase of the contract will cover the design and fabrication of a radiation-hardened modulator ASIC. GRC will manage the digital modem development with SiCOM through all phases of the contract. The initial phase will result in the delivery to GRC of space-qualifiable ASICs for the modulator portion of the modem. GRC will benefit from the development and possession of this technology by better serving the space communications needs of the NASA Enterprises. GRC will work with the NASA Goddard Space Flight Center (GSFC) and the NASA Johnson Space Center (JSC) to identify communication technology requirements for Earth Science missions and for the International Space Station (ISS), where this modem may be used.

Sandia has strong technical capabilities in the design, development, fabrication, evaluation, and testing of radiation hardened microelectronics. In the area of radiation hardened (rad-hard) electronics, the drive to higher levels of integration and greater bandwidth communications has been fueled by the needs of the national security missions. Sandia will participate in the modulator development through technical consulting and will offer testing of the space-qualifiable ASIC. Sandia will benefit from the development of high-speed rad-hard modem technology. The availability of rad-hard modem ASICs will greatly enhance Sandia's ability to deliver next generation satellites for nonproliferation that are smaller and have enhanced sensing ability. In addition, fielding of nanosatellite devices for worldwide communications will enable high-speed ATM links. These links can be expected to be operating at over 155Mbps. Greater sensor capability will enable even higher network bandwidth requirements. In addition, the development of high-speed modem technology will enhance Sandia's ability to respond to future threats to the national security.

Sandia and GRC will coordinate their ongoing programs in the area of radiation hardened digital communication devices. Additional collaboration activity may be identified and proposed in the area of High-Rate, Radiation Hardened Digital Modems or in additional areas of Advanced Communications Technology Development.

Milestone Schedule for Rad-Hard Modulator ASIC Development

Award Contract	1/1999
SiCOM Kickoff Meeting @ GRC	2/1999
Critical Design Review (CDR)	9/1999
Pre-Production ASICs	2/2000
Radiation testing at Sandia	2/2000
Final ASICs Delivered	3/2000

This description in this addendum of collaboration under this MOU between the NASA Glenn Research Center and the Sandia National Laboratories does not constitute a commitment of resources, internally or externally, by either party.

The undersigned approve the collaboration activity described in this Addendum A to the Sandia/ NASA GRC MOU dated 4-8-99 entitled, "The Development and Implementation of Strategic Technical Collaboration Activities."

For the SANDIA CORPORATION	**For the NATIONAL AERONATUICS and SPACE ADMINISTRATION GLENN RESEARCH CENTER**
_____	_____
Alton Romig, Vice President for Science, Technology and Components	Gerald J. Barna, Director of Space
Date: _____	Date: _____